Draft Stage 1 Remedial Action Plan for Barangaroo, Hickson Road, Sydney

Sydney Harbour Foreshore Authority

July 2007

0065952RP02 Rev 03 Draft

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ERM

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Environmental Resources Management Australia Pty Ltd Quality System

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This report was prepared in accordance with the scope of services set out in the contract between Environmental Resources Management Australia Pty Ltd ABN 12 002 773 248 (ERM) and the Client. To the best of our knowledge, the proposal presented herein accurately reflects the Client's intentions when the report was printed. However, the application of conditions of approval or impacts of unanticipated future events could modify the outcomes described in this document. In preparing the report, ERM used data, surveys, analyses, designs, plans and other information provided by the individuals and organisations referenced herein. While checks were undertaken to ensure that such materials were the correct and current versions of the materials provided, except as otherwise stated, ERM did not independently verify the accuracy or completeness of these information sources

DRAFT REPORT

Sydney Harbour Foreshore Authority

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July 2007

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1 INTRODUCTION

1.1 BACKGROUND

Barangaroo (the Site) is a 22 hectare (ha) parcel of land located at Berths 3 -8 Hickson Rd, Millers Point, on the western side of the Sydney Central Business District (CBD). The NSW government has decided to redevelop the Site as an extension of Sydney's business core and to provide the community with approximately 11 Ha of new waterfront public open space.

Environmental Resources Management Australia Pty Ltd (ERM) understands that the majority of the Site is to be progressively vacated by the current occupants (Patrick Stevedoring) in 2007. During late 2007/early 2008, the majority of the structures on the site are to be demolished and the Site made level and clear in preparation for any interim uses of the Site. The concept design for the redevelopment of the site includes plans for more than half of the site to form a new foreshore park with commercial floor space to be the dominant built form land use with some high density residential included.

ERM was commissioned by Sydney Harbour Foreshore Authority (the Foreshore Authority) to prepare this Remedial Action Plan (RAP) for the proposed Demolition Works at Barangaroo. It is understood that additional "stages" of the RAP will be added as the redevelopment progresses.

1.2 OBJECTIVE

The objective of this project was to prepare a Stage 1 Remedial Action Plan (RAP) which will:

- Facilitate the completion of hazardous building materials removal, demolition and any required remedial works in a manner that meets both stakeholder and relevant legislative requirements;
- Set a remediation goal that will facilitate the completion of works to render the Site suitable for its proposed short term use (as the venue for a public event);
- Provide procedures and plans for the completion of proposed remedial works; and
- Identify the environmental safeguards necessary to complete the proposed remedial works in a manner that minimises negative impacts upon worker health and safety and the environment.

1.3 SCOPE OF WORK

The scope of this Stage 1 RAP is limited to rendering the Site suitable for its proposed use (in the short term) as the site for interim public uses. It is noted that an additional stage or stages of significant remediation will be required in the future in order to render the site suitable for its longer term proposed land use following redevelopment (i.e. open space/commercial/high density residential). This RAP has therefore been identified as the "*Stage 1 RAP*" in order to distinguish it from future RAPs which will be required to cover the more significant remedial works envisaged for the Site.

It is proposed that the Stage 1 remediation will incorporate the following scope of works:

- Tendering of Demolition and Remedial Works Contract and Engagement of a suitably qualified Contractor;
- Contractor mobilisation and site establishment;
- Removal of hazardous building materials;
- Demolition/dismantling of site structures to top of footing level;
- Removal/demolition of all footings which protrude above slab level;
- Appropriate off site disposal/recycling of demolition materials in accordance with relevant legislative requirements;
- Reinstatement of hardstanding in areas where footings or other structures have been removed and underlying soils exposed;
- Final preparation of the site such that the surface is covered with hardstanding and no significant trip hazards exist;
- Validation of the remedial works by a suitably qualified environmental consultant;
- Contractor demobilisation;
- Preparation of a validation report for submission to the NSW EPA Accredited Site Auditor; and
- Preparation of a Site Audit Statement and Site Audit Report by the NSW EPA Accredited Site Auditor which states that the site is suitable for its proposed use (in the short term) for interim public uses.

2 SITE DESCRIPTION

2.1 SITE IDENTIFICATION

The Site is located at Berths 3 – 8 Hickson Road Millers Point, New South Wales; and is referenced as Lots 1 through 6 of DP876514, City of Sydney, Parish of Saint Philip, County of Cumberland (*Figure 1* of *Annex A*). The Site covers an area of approximately 22 hectares and is located approximately 500 metres west of Sydney's central business district (CBD). A current site layout plan is included as *Figure 2* of *Annex A*. The elevation of the site varies from approximately two to three m Australian Height Datum (AHD) and the Map Grid of Australia 1994 (MGA94) coordinates for the approximate centre of the site are:

- Easting– 333643.69 m E; and
- Northing - 6251851.71 m S.

2.2 SITE USAGE AND HISTORY

2.2.1 *Current Site Zoning and Usage*

The site is currently zoned *Maritime and Transport in Central Sydney*. During site investigation works conducted by ERM during 2006 and reported in February 2007, it was noted that the Site comprised a mixture of uses including:

- An active passenger terminal, shipping control tower, offices and storage areas operated by Sydney Ports Corporation;
- An active stevedoring terminal including four large transit warehouses and equipment maintenance facilities operated by Patrick General Stevedoring; and
- The far north eastern portion of the site, known as Moores Wharf, contains a large heritage listed sandstone building utilised as a base for marine operations by Sydney Ports Marine Services.

It is understood that the Foreshore Authority will assume ownership of the site as of late 2007 and during late 2007/early 2008 the majority of the current structures associated with the stevedoring terminal are to be demolished and the Site made level and clear. Prior to any future redevelopment it is understood that the Site may be used for short term outdoor events.

The surrounding land uses comprise primarily commercial with some residential properties. The Site is bound by Sydney Harbour to the north and west, and Hickson Road to the east. Beyond Hickson Road lies the Sydney CBD predominantly comprising high density commercial buildings. To the south of the Site is the commercial King Street Wharf area, comprising retail shops, restaurants and residential apartments.

2.2.2 *Chronology of Site Activities*

Following a review of existing reports, land title searches and aerial photography (refer to *Figure 3* of *Annex A*), the historical activities carried out at the Site can be summarised as follows:

- 1839: Part of the Site was selected by The Australian Gas Light Company (AGL) as the site for a gasworks to supply town gas to the City of Sydney. The remainder of the site was likely used for ship berthing and associated activities.

- 1840: Construction of the AGL gasworks began on part of the Site. The gasworks site extended across what is now Hickson Rd. and onto the properties on the opposite side (refer to *Figure 2* of *Annex A*). The remainder of the site was likely used for ship berthing and associated activities.

- 1841 to 1921: The gasworks commenced production of gas in June 1841 and was operated and continued to be developed by AGL over the next eighty years. The remainder of the site was likely used for ship berthing and associated activities. Several of the current lots were created between 1910 and 1916 by the Sydney Harbour Trust Commissioners who then acquired the lots. AGL leased back the gasworks site from the Sydney Harbour Trust Commissioners until 1921 (URS, 2001).

- 1922 to 1925: The gas holders and purifier beds associated with the AGL gasworks were demolished to ground level and the gas holding tanks were backfilled. The fill in the gas holder pit is reported to contain odorous tarry material from 2 m bgl depth (URS, 2001).

- 1925 to 1936: The majority of the site continued to be owned by the Sydney Harbour Trust Commissioners and was used for ship berthing and associated activities.

- 1936 to 1998: Lots 1 through 6 were owned by the Maritime Services Board of NSW and subject to various commercial leases. The majority of the remainder of the Site initially consisted of finger wharves, which were removed over time and large areas of land reclaimed from the harbour with unclassified fill between 1951 and 1972. In 1996 a vehicle maintenance area including wash bay, waste oil store and above ground diesel fuel tanks was identified.

- 1998 to 2007: Marine Ministerial Holding Corporation was the proprietor of Lots 1 and 6. Sydney Ports Corporation was proprietor of Lot 2, 3, 4 and 5. Land uses were as described in *Section 2.2.1*.

- November 2006: The NSW Department of Environment and Conservation (DEC) – now known as the Department of Environment and Climate Change (DECC) proposed in a letter to the Foreshore Authority (Ref: DOC06/54850 FIL06/1251-02) that the part of the Barangaroo Site formerly occupied by the AGL gasworks (refer to *Figure 2* of *Annex A*) along with the adjoining portion of Hickson Rd, and the properties located on the eastern side of Hickson Rd (36 and 38) pose a Significant Risk of Harm (SRoH) and that these areas should be declared an Investigation Area under Section 15 of the Contaminated Land Management (CLM) Act.

2.3 *SITE CONDITION AND SURROUNDING ENVIRONMENT*

The Site covers an area of approximately 22 hectares and is relatively flat, having been cut and filled to level for its current purpose as a passenger and stevedoring terminal. The site is surrounded on the landward boundaries by a "chain link" steel mesh security fence and abuts a cliff face on the eastern boundary in the northern portion of the site. Wharf faces are present on the western and northern boundaries adjoining the harbour. The vast majority of the site is covered with buildings or concrete/asphaltic concrete hardstanding, which was generally observed to be in good condition during ERM's 2006 site works. There is a limited amount of vegetation present on the site in some small garden areas, predominantly around the passenger terminal on Wharf 8. None of the reports reviewed indicated visible signs of plant stress.

There are no permanent surface water bodies present on the site itself and stormwater is collected via a network of surface and below ground drains as indicated in the services diagram presented as *Figure 4* of *Annex A*. The water quality in Sydney Harbour, and more particularly Darling Harbour, which is the closest surface water body to the site, is known to have been significantly degraded by industrial and urban activities within the catchment area. *"Darling Harbour has frequently been the most polluted of the Sydney Harbour sites monitored as part of the Harbourwatch Program. This was again the case in 2005–2006, with Darling Harbour frequently having elevated faecal coliform and enterococci levels. Swimming by the general public is not permitted in Darling Harbour."* [1]

[1] http://www.environment.nsw.gov.au/beach/ar2006/specialstudies-01.asp).

Several Potential Areas of Environmental Concern were identified in both Noel Arnold (1996) *Initial Environmental Assessment, Sydney Ports Corporation, Darling Harbour, Berths 3-8 Hickson Road, Darling Harbour* and more recently in ERM (2007) *Environmental and Geotechnical Site Assessment, East Darling Harbour, Sydney, NSW.* These areas included:

- The western part of Berths 3 – 8, where uncharacterised fill material have historically been used to reclaim land that was formerly finger wharves;
- The Former Gasworks Area;
- Two equipment Wash Bays, two diesel above ground storage tanks (ASTs) and bowsers, a propane gas tank, dangerous goods storage area and workshop all associated with Patrick's vehicle and equipment maintenance area;
- An area of oil staining in the south-west corner of Transit Shed No. 5 possibly associated with a former AST; and
- A 15 000 litre diesel underground storage tank (UST), dangerous goods storage unit, oil water separator and 10 000 litre petrol AST associated with Ports Operations activities in the Moore's Wharf area of the Site.

These Potential Areas of Environmental Concern are shown in *Figure 2* of *Annex A*.

A number of the buildings on the Site are known to contain hazardous building materials, including significant quantities of bonded asbestos roof sheeting on the large transit warehouses. Further details of the hazardous building materials identified on the site are provided in two reports prepared by Noel Arnold and Associates for Sydney Ports Corporation (SPC):

- Noel Arnold and Associates (March 2001) *Hazardous Materials Survey Report, Sydney Ports Corporation, 35 Hickson Rd, Darling Harbour NSW.*
- Noel Arnold and Associates (June 2006) *Hazardous Materials Re-Inspection Survey Report, Sydney Ports Corporation, 35 Hickson Rd, Darling Harbour NSW.*

2.4 GEOLOGY AND HYDROGEOLOGY

2.4.1 Geology

Information from the 1 : 100 000 Geological Survey of NSW (Sydney) Sheet 9130 indicates that the Site is generally underlain by man-made fill consisting of "dredged estuarine sand and mud, demolition rubble, industrial and household waste" and Hawkesbury Sandstone of the Wianamatta Group. This is consistent with the geology observed during the ERM (2007) investigation. A total of 153 boreholes were advanced across the site, with the geology generally described as follows:

- FILL, grey/brown gravely/silty sand, poorly sorted, fine to coarse grained with igneous inclusions.
- SANDY CLAY, brown/grey, moist, natural marine sediments.
- SANDSTONE BEDROCK, brown/ grey, fine/medium grained sandstone (Hawkesbury Sandstone).

The northern and eastern areas of the site were generally devoid of the natural sediment layer with fill overlying sandstone bedrock. The central and southern portions of the site generally exhibited fill underlain by natural sediments above sandstone bedrock.

An interpretive three dimensional model created from geological data gathered during drilling works conducted on site by ERM during 2006 is presented as *Figure 5* of *Annex A* and a plan showing contours of the interpreted depth of fill materials across the site is presented as *Figure 6* of *Annex A*.

2.4.2 Hydrogeology

Significant short term fluctuations in groundwater levels were observed during ERM's 2006 drilling works, indicating a strong tidal influence. Anecdotal evidence provided by site employees also indicated that groundwater flow in the vicinity of the former gasworks may be influenced by dewatering activities undertaken regularly in the basements of buildings on the eastern side of Hickson Road. Groundwater was observed between 0.07 m AHD and 0.648 m AHD with the general groundwater flow direction considered to be towards the south east (refer to *Figure 7* of *Annex A)* although it was noted that further investigations would be required to gain an accurate understanding of the hydrogeological regime at the site (ERM, 2007).

2.4.3 *Groundwater Usage*

Following a review of hydrogeological information obtained from the Department of Natural Resources (DNR), ERM understands that there are 32 registered groundwater bores within a 4 km radius of the Site. Review of the groundwater abstract bore information indicated that eight of these bores are used for recreational purposes, three are used for irrigation and 22 are used for groundwater monitoring. None of these were located on the site and none are reported as being used for drinking water extraction.

3 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) were developed to define the type and quality of data required to achieve the project objectives outlined in *Section 1*. The DQOs were selected with reference to relevant guidelines published by the NSW EPA, ANZECC and National Environment Protection Council (NEPC), which define minimum data requirements and quality control procedures.

Specific guidelines referenced include:

- Australian Standard AS 4482.1-1999, *Guide to Sampling and Investigation of Potentially Contaminated Soil (Part 1: Non-volatile and semi-volatile compounds)*;
- Australian Standard AS 4482.2-1999, *Guide to Sampling and Investigation of Potentially Contaminated Soil (Part 2: Volatile Substances)*;
- ANZECC (Australia and New Zealand Environmental and Conservation Council) (2000) Australia and New Zealand Guidelines for Fresh and Marine Water Quality;
- NSW DUAP (1998) Managing Land Contamination: *Planning Guidelines, SEPP 55 Remediation of Land*;
- National Environment Protection Council (1999) National Environment Protection (Assessment of Site Contamination) Measure 1999, Schedule B (2) – *Guideline on Data Collection, Sample Design and Reporting*;
- NSW EPA (1994) *Guidelines for Assessing Service Stations*;
- NSW EPA (1995) *Sampling Design Guidelines*;
- NSW EPA (1997) *Guidelines for Consultants Reporting on Contaminated Sites*;
- NSW EPA (1999) *Guidelines on Significant Risk of Harm from Contaminated Land and the Duty to Report*;
- NSW DEC (2006) *Guidelines for the NSW Site Auditor Scheme - 2nd Edition*; and
- NSW DEC (2007).

The DQO process used followed the seven-step approach identified in NSW DEC (2007) as described in the following sections.

3.1 STEP ONE – STATE THE PROBLEM

Previous investigations conducted on the site identified contamination of soil and groundwater associated with the historical use of parts of the site as a gasworks, historical land reclamation and other potentially contaminating activities. The primary aim of this project, as described in *Section 1.2*, is to render the Site suitable for its proposed use as the venue for a short term public event.

3.2 STEP TWO – IDENTIFY THE DECISION

The decision to be made with respect to the contamination at the site relates to whether the site has been made suitable for its proposed use as the venue for a short term public event.

3.3 STEP THREE – IDENTIFY INPUTS TO THE DECISION

The scope of work for this investigation was based on the following:

- Information provided directly to ERM by the Foreshore Authority;
- a review of available historical information including previous reports prepared by various consultancies;
- a review of the *Draft Demolition Plans and Specifications* prepared by Turner and Associates (2007);
- a review of previous investigations conducted by others;
- a review of data gathered during site investigation works completed by ERM in 2006; and
- ERM (2007) *Draft Qualitative Human Health Risk Assessment, Barangaroo.*

3.4 STEP FOUR - DEFINE THE BOUNDARIES OF THE STUDY

The extent of the area to which this RAP applies is as described in *Section 2.1* and shown on *Figure 2* of *Annex A*. As noted in *Section 1.3*, temporally, this RAP applies only to the short term use of the site as the venue for a public event.

3.5 *STEP FIVE – DEVELOP A DECISION RULE*

In view of the Tier 1 screening exceedences identified in the ERM (2007) Environmental Site Assessment report, a qualitative human health risk assessment (Ref: 0065952RP01) was prepared by ERM to guide management decisions regarding the identified contamination on site in relation to the proposed short term use of the site. A key outcome of this qualitative risk assessment was the identification of the need to complete further quantitative risk assessment.

If the outcome of this pending quantitative risk assessment is that an unacceptable level of risk or uncertainty surrounding the risks is identified, then appropriate measures to mitigate these risks or uncertainties must be implemented.

3.6 *STEP SIX – SPECIFY LIMITS ON DECISION ERRORS*

Measured vapour concentrations across the site must not represent a significant risk to human health as assessed in a quantitative human health risk assessment completed in accordance with relevant NEPC (1999) guidance.

Laboratory QA/QC procedures and data used as input to the risk assessment will be assessed in accordance with the National Environment Protection (Assessment of Site Contamination) Measure 1999, *Schedule B (3) - Guidelines on Laboratory Analysis of Potentially Contaminated Soils.*

3.7 *STEP SEVEN – OPTIMISE THE DESIGN FOR OBTAINING DATA*

A sampling, analysis and quality plan for the validation program will be developed based on the NEPM (1999), *Schedule B (2) - Guideline on Data Collection, Sample Design and Reporting.* and NSW EPA *Guidelines for Consultants Reporting on Contaminated Sites* prior to the commencement of validation works.

The aim of establishing the DQOs outlined above prior to the project commencement was to ensure the accuracy, precision, comparability, representativeness and completeness of the data generated.

4 PROPOSED ASSESSMENT CRITERIA

4.1 SOIL

ERM understands that the intended short term future land use of the site is primarily open space during the public event. The NEPM (1999) HIL 'E' guidelines are, therefore, considered the most appropriate Tier One screening criteria. The adoption of the NSW EPA (1994) *Guidelines for Assessing Service Station Sites* threshold concentrations for *Sensitive Landuse – Soils* for Total Petroleum Hydrocarbons is also considered appropriate.

4.2 GROUNDWATER

Given the proximity of the site to Sydney Harbour, the most appropriate Tier 1 screening criteria for groundwater are considered to be the ANZECC 2000 95% protection trigger value for marine waters. In the absence of a 95% trigger value for particular compounds, ANZECC 2000 Low Reliability Trigger Values (LRTVs) should be applied.

4.3 VAPOUR

Given the nature and extent of contamination identified by the Stage 1 and 2 ESA conducted by ERM (0044432RP02) it is accepted that exceedences of these criteria will be identified in portions of the site. It is, therefore, considered that a site specific Tier II quantitative risk assessment should be conducted to identify and quantify potential risks posed to human health by the identified contamination. A key aspect of this risk assessment will be the assessment of potential risks posed by organic vapours emitted from the site surface and service pits or drainage lines. ERM understand that an initial round of ambient air and flux chamber monitoring is likely to be conducted prior to the commencement of the demolition works. This will provide valuable data for inclusion in the risk assessment.

5 *PREVIOUS INVESTIGATIONS*

Numerous Environmental Site Assessments have been conducted on the Site and neighbouring parts of the former gasworks as summarised below:

- AGC Woodward-Clyde Pty Ltd (1993) *Maritime Services Board MSB) Site – Hickson Road, Sydney, Preliminary Contamination Review;*
- Johnstone Environmental Technologies (1993) *Report on Site Contamination Investigation at MSB Property, Hickson Road, Sydney (Former AGL gasworks site);*
- Axis Environmental Consultants Pty Ltd (1994) *Environmental Assessment, Hickson Road for MSB;*
- Axis Environmental Consultants Pty Ltd (1994) *Summary Contamination Report, Hickson Road Site for MSB;*
- Noel Arnold and Associates Pty Ltd (1996) *Initial Environmental Assessment, Sydney Ports Corporation, Darling Harbour, Berths 3-8 Hickson Road, Darling Harbour;*
- AGC Woodward-Clyde Pty Ltd (1996) *Wharf 7-8 Darling Harbour – Installation of PABX Cable;*
- Coffey Partners International Pty Ltd (1998) W*harf 8 Darling Harbour Environmental Soil Quality Assessment;*
- Hyder Consultants (1998) *Environmental Site Assessment Hickson Road and Port Area, Millers Point, Sydney;*
- AGC Woodward-Clyde (1999) *Contamination Review and Development of Remediation Scenarios, 30-38 Hickson Road, Millers Point, Sydney;*
- The LHO Group (1999) *Report on No. 30-38 Hickson Road, Sewerage Pumping Station No. 59 and Rising Main;*
- AGC Woodward-Clyde (1999) *Stage 1 Masterplan, 30-38 Hickson Road, Contamination Assessment and Remediation Options;*
- URS Australia Pty Ltd (2001) *Contamination Review for Darling Harbour – Berths 3-8;* and
- Environmental Resources Management Australia Pty Ltd (2007) *Environmental and Geotechnical Site Assessment, East Darling Harbour, Sydney, NSW.*

Of these reports, only those prepared by Noel Arnold and Associates (1996), Coffey Partners International (1998), URS Australia (2001) and ERM (2007) were available to ERM for review; however, it is noted that the URS (2001) report provides a summary of information from the earlier reports.

It is also understood that additional documents including a RAP for remedial works conducted on the eastern side of Hickson Road, have been prepared, however these were unavailable for review at the time of writing.

Table 5.1 (below) provides a summary of the reports reviewed:

Table 5.1 Summary of Previous Investigations

Date of Publication	Consultant	Report Title and Key Issues Identified.
January, 1986	ARUP Geotechnics	Upgrading Wharf 7/8 Darling Harbour, Geotechnical Site Investigation. This investigation details soil/rock design parameters for analyses, advice on foundation system options and recommendations on the most suitable type of foundation for proposed development on Wharf 7/8.
June, 1996	Noel Arnold &Associates Pty Ltd.	Initial Environmental Assessment, Sydney Ports Corporation, Darling Harbour, Berths 3-8 Hickson Road, Darling Harbour. This report details the findings of an environmental assessment completed to provide an initial assessment of contamination, to identify breaches of environmental law and to recommend any remedial work to ensure compliance with relevant environmental law or to allow the use of the site without material risks to health and safety. The assessment found that known and potential contamination at the site did not present a material risk to health and safety for the Patrick's Stevedores occupancy at the site providing subsurface materials were not actively disturbed by excavation or similar works. The areas of known contamination were identified as the former gas works area. The areas with potential contamination identified included: Filled areas of the site. Areas around the mechanical workshop, waste oil storage, above ground fuel tanks and vehicle wash areas. The assessment also highlighted issues of possible non-compliance with license requirements and general legal obligations in relation to storage and handling of fuels and waste oils, operation of vehicle washbays, and the management of stormwater.

Date of Publication	Consultant	Report Title and Key Issues Identified.
March, 1998	Coffey Partners International Pty Ltd.	Wharf 8 Darling Harbour Environmental Soil Quality Assessment This Assessment included limited soil sampling across Wharf 8 which was completed to assess soil contamination and to identify waste disposal options for soil that would be excavated as part of a proposed Wharf Development. Conclusions of the assessment are as follows: Wharf 8 soil contains low level PAH contamination. However the contamination does not pose an unacceptable level of health risk. Fill removed from site for waste disposal is likely to be classified as industrial waste or hazardous waste.
July, 2001	URS Ltd.	Contamination Review for Darling Harbour- Berths 3-8. This document is a review of eleven reports produced by various consultants since May 1993 on the Darling Harbour-Berths 3-8 area. The review is a summary of the contamination identified on site in these reports. Key contamination issues identified in the review are as follows: Soil contamination related to the use of fill on site, particularly the former finger wharfs and former gas works. Soil contamination connected with dumping of wastes on site, particularly from the former gas works. Soil contamination from current vehicle maintenance operations. Groundwater contamination associated with on site sources of soil contamination identified above. Groundwater contamination migrating on site from upgradient sources of contamination, particularly the area of Hickson Road formerly occupied by the gasworks adjoining the site.

6 SITE CHARACTERISATION

6.1 NATURE OF IDENTIFIED CONTAMINATION

6.1.1 Soil

Following the most recent Site investigation works, ERM (2007) reported the analytical results for 347 primary soil samples collected from 153 boreholes. The locations of these sampling points are illustrated on *Figure 2* of *Annex A*. It is noted that not all suspected areas of impact (including some gas works structures) could be sampled due to access restrictions and adverse drilling conditions. Samples were analysed by a NATA accredited laboratory for a suite of analytes, including inorganics (arsenic, cadmium, total chromium, copper, lead, mercury, nickel, zinc, sulphate and cyanide), total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene, and xylenes (BTEX compounds), polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides (OCPs), organophosphorous pesticides (OPPs), total polychlorinated biphenyls (PCBs) and phenolic compounds.

Table 6.1 provides a summary of the maximum detected soil concentrations reported from the soil sampling conducted between May and August 2006 (ERM, 2007). It is noted that OCPs, OPPs, PCBs and phenolic compounds were reported below the laboratory limit of reporting (LOR) in all samples analysed.

Table 6.1 Maximum Soil Concentrations (ERM 2007)

Analyte	Location	Depth (m bgl)	Maximum Detected Concentration (mg/kg)
Arsenic	BH126	1.5-1.95	77
Cadmium	BH150	3-3.45	2
Chromium	BH033	1.5-1.95	141
Copper	BH074	1.5-1.95	1 410
Lead	BH067	1.5-1.95	**13 600**
Mercury	BH115	0.8-1	9.1
Nickel	BH053	0.3-0.5	164
Zinc	BH067	1.5-1.95	4 770
Sulphate	BH001	1	31 500
Cyanide Total	BH062	1.5-1.95	489
TPH C_6 – C_9 Fraction	BH119	7.5-8	**1 140**
TPH C_{10} - C_{14} Fraction	BH119	7.5-8	6 750
TPH C_{15}-C_{28} Fraction	BH119	7.5-8	13 000
TPH C_{29}-C_{36} Fraction	BH119	7.5-8	4 690
TPH C_{10} - C_{36} Total	BH119	7.5-8	**24 440**
Benzene	BH132	8-8.5	**140**
Toluene	BH132	8-8.5	**232**
Ethylbenzene	BH119	7.5-8	**63**
m- & p-xylene	BH132	8-8.5	225
o-xylene	BH132	8-8.5	120
Xylene Total	BH132	8-8.5	**345**

Analyte	Location	Depth (m bgl)	Maximum Detected Concentration (mg/kg)
Acenaphthene	BH141	3-3.45	127
Acenaphthylene	BH141	3-3.45	600
Anthracene	BH141	3-3.45	499
Benz(a)anthracene	BH141	3-3.45	429
Benzo(a) pyrene	BH141	3-3.45	**344**
Benzo(b)fluoranthene	BH141	3-3.45	359
Benzo(g,h,i)perylene	BH141	3-3.45	149
Benzo(k)fluoranthene	BH141	3-3.45	140
Chrysene	BH141	3-3.45	328
Dibenz(a,h)anthracene	BH141	3-3.45	35.4
Fluoranthene	BH141	3-3.45	1 160
Fluorene	BH141	3-3.45	725
Indeno(1,2,3-c,d)pyrene	BH141	3-3.45	124
Naphthalene	BH141	3-3.45	5 840
Phenanthrene	BH141	3-3.45	1 820
Pyrene	BH141	3-3.45	980
PAHs (Sum of total)	BH141	3-3.45	**13 659.4**

6.1.2 *Groundwater*

Groundwater was present in all monitoring wells installed on-site. The depth to water observed ranged from 1.7 to 2.495m bgl. Some significant short term variations in groundwater levels were observed during drilling and sampling operations, particularly in those wells located close to the seawall. This, along with the generally saline nature of the groundwater, indicates that the groundwater regime on the site is likely to be strongly influenced by tidal fluctuations.

Anecdotal evidence provided by site employees and representatives of SHFA indicated that groundwater flow in the vicinity of the former gasworks may also be influenced by dewatering activities in the basements of buildings on the eastern side of Hickson Rd.

Although groundwater at the site would be anticipated to flow toward Sydney Harbour, the hydrogeological regime appears to be heavily influenced by tidal fluctuations and the dewatering activities on the eastern side of Hickson Road. This may provide some explanation for the variable groundwater elevations noted on site.

Results of the laboratory analysis of groundwater samples collected indicate that the majority of criteria exceedences appear related to the affected soils in the area of the former gasworks. There is, however, some impact observed in wells that may be related to other sources, such as the underground storage tank (USTs) in the north eastern corner.

The constituents of concern identified in these areas were:

- Polycyclic Aromatic Hydrocarbons (PAHs);
- Total Petroleum Hydrocarbons (TPH);

- Benzene, Toluene, Ethylbenzene and Xylenes;
- Metals; and
- Cyanide.

Table 6.2 Maximum Detected Groundwater Concentrations

Analyte	Location	Maximum Detected Concentration (ug/L)
Inorganics		
Arsenic (Filtered)	MW08	**20**
Cadmium (Filtered)	MW08	**34.2**
Chromium (Filtered)	MW08	15
Copper (Filtered)	MW08	6
Lead (Filtered)	MW08	**555**
Mercury (Filtered)	MW15	0.3
Nickel (Filtered)	MW21	24
Zinc (Filtered)	MW08	**764**
Cyanide Total	MW08	**392**
Cyanide (Free)	MW08	11
Sulphate (Filtered)	MW03	3 240 000
TPH & BTEX Compounds		
TPH C_6 – C_9 Fraction	MW15	31 500
TPH C_{10} - C_{14} Fraction	MW15	50 500
TPH C_{15}-C_{28} Fraction	MW15	22 700
TPH C_{29}-C_{36} Fraction	MW08	2 580
TPH C_{10} - C_{36} Total	MW15	**74 540**
Benzene	MW15	**14 400**
Toluene	MW15	**5 740**
Ethylbenzene	MW15	**3 020**
m- & p-xylene	MW15	4 490
o-xylene	MW15	2 210
Xylene Total	MW15	**6 700**
Polycyclic Aromatic Hydrocarbons		
Acenaphthene	MW15	112
Acenaphthylene	MW15	696
Anthracene	MW15	161
Benz(a)anthracene	MW15	145
Benzo(a) pyrene	MW15	**91**
Benzo(b)fluoranthene	MW15	118
Benzo(g,h,i)perylene	MW15	37.5
Benzo(k)fluoranthene	MW15	31.3
Chrysene	MW15	97.3
Dibenz(a,h)anthracene	MW15	8.4
Fluoranthene	MW15	480
Fluorene	MW15	491
Indeno(1,2,3-c,d)pyrene	MW15	35
Naphthalene	MW15	21 700
Phenanthrene	MW15	932
Pyrene	MW15	451
PAHs (Sum of total)	MW15	23 350.4

There appears to be significant potential for migration of mobile contaminants both onto the site (from the area of Hickson Road formerly occupied by the gasworks) and off the site (to Sydney Harbour and possibly the area of Hickson Road formerly occupied by the gasworks).

6.2 *EXTENT OF IDENTIFIED CONTAMINATION*

The ERM (2007) report identified two primary areas of the Site with elevated concentrations of chemicals of potential concern in the soil. These were the former gasworks area located in the south east portion of the Site and the north western portion of the Site that had been reclaimed historically using uncharacterised fill and wastes from the gasworks. Groundwater impacts were also identified in association with the former gas works and near an UST located in the north eastern corner of the Site (refer to *Figure 2* of *Annex A*).

6.3 *POTENTIAL CHEMICAL DEGRADATION PRODUCTS*

The environmental fates of the identified constituents of concern are likely to be strongly influenced by degradation processes, both physicochemical and biological. Physicochemical processes include sorption, dilution, dispersion, volatilisation, hydrolysis and oxidation/reduction. Biological processes such as uptake and/or metabolism by living organisms are more likely to affect the environmental fate of organic compounds in comparison to inorganics, which exhibit toxicity in the elemental form. The more water soluble hydrocarbons such as BTEX compounds and low-molecular weight PAHs are considered more susceptible to the effects of dilution and dispersion processes (Uchrin and Katz, 1991) along with volatilisation and biological degradation processes (Park *et al.*, 1990). Conversely the more hydrophobic or higher molecular weight PAH compounds have been found to be more resistant to biological degradation and more persistent in the environment due to a lower tendency to move through soil or groundwater (Enzminger and Ahlert, 1987).

PAHs are significant components of the higher molecular weight TPH constituents. In the environment, PAH compounds generally bind strongly to soils and sediments and do not readily dissolve in water. This behaviour decreases as the molecular weight of the compound decreases. Oxidation and photolysis are important PAH degradation processes in the environment, however the extent to which these occur is limited in soil and groundwater. No evidence is available to indicate that hydrolysis or volatilisation are significant degradation pathways. Biodegradation by microorganisms is therefore considered to be the primary mechanism by which this chemical is broken down. This process occurs relatively slowly and due to their lipophilicity PAHs may bioaccumulate in organisms unable to metabolise them. The main metabolites of PAHs due to biological degradation include aromatic ketones, quinones, hydroxylated and dihydroxylated compounds. These metabolites are of varying toxicity and are not necessarily considered to be of lesser toxicity than the parent compound, however little published research is available on the many potential metabolites.

BTEX compounds represent a significant fraction of the lower molecular weight TPH constituents. In the environment, BTEX compounds rapidly undergo volatilisation and photolysis and are also subject to biodegradation under aerobic conditions. These hydrocarbons are fairly soluble in water but do not generally adsorb to sediment or hydrolyse. Benzene is degraded to phenols and hydroxylated compounds. The degradation products are generally considered to be of lower toxicity but greater environmental persistence than the parent compound.

6.4 POTENTIAL EXPOSURE PATHWAYS AND RECEPTORS

As the Site surface will be finished entirely with hardstanding, direct exposure pathways to soil contamination (i.e. ingestion, dermal contact and dust inhalation) for potential future event employees or event attendees (the identified receptors) are not considered to be relevant as a complete linkage is not considered to exist. Exposure to the on-Site receptors may potentially arise due to indirect (i.e. vapour inhalation) pathways from soil contamination. Although it is understood that no permanent buildings will be present on the Site at the time of the short term public event, indoor vapour inhalation pathways are considered possible as well as outdoor inhalation pathways as temporary buildings (e.g. marquees) may be brought on-Site for the event.

It should be noted that the potential exposure of workers involved with the demolition and remedial works is to be addressed separately in a detailed site specific health and safety plan and has therefore not been included within this assessment.

Significant dissolved phase groundwater impacts have been recorded in on-Site monitoring wells. Human exposure to groundwater via direct pathways (dermal absorption or ingestion) is unlikely as there are no registered groundwater bores on the Site and no groundwater extraction is known to occur. However, there is a potential for on-Site receptors to be exposed to contamination from volatile organic compounds that might potentially volatilise from the groundwater. Both indoor and outdoor vapour inhalation pathways should therefore be assessed.

7 REMEDIAL ACTION PLAN

7.1 REMEDIATION GOAL

The goal of the proposed remedial works is to render the Site suitable for its proposed use as the venue for a short term public outdoor event.

7.2 EXTENT OF REMEDIATION REQUIRED

While it is understood that a much larger remediation undertaking will be required to prepare the site for development, this RAP addresses the requirements for preparing the site for a short term public event. As such, there are three components that will be required:

- Demolition of existing structures;
- Removal of all footings, flooring and obstacles, which pose a tripping hazard for the public event; and
- Site Preparation (paving).

The works required will need to be undertaken in a manner that minimises the potential exposure risks throughout the demolition / remediation programme and short term site usage. It should be noted that the Site will not be completely cleared in this Stage 1 work, but rather will be made safe and "useable" for the short term public event. More extensive demolition, excavation and remediation will be required for re-development of the Site, which will be completed in later stages.

It is noted that whilst the overall scope of the proposed works includes demolition, remediation and hazardous material removal, the following sections refer to contamination issues only.

7.3 ASSESSMENT OF REMEDIAL OPTIONS

Several remedial options for the areas of concern at the site were examined as part of the DQO process. A selection was made based on environmental impacts, time constraints, site logistics, health concerns and cost. The remedial options considered are outlined below.

7.3.1 *Do Nothing*

This approach was eliminated for several reasons, including:

- The areas of concern will pose a potential health risk during demolition works to on-site workers;
- A potential continued health risk is likely to occur during the public event for attendees and workers; and
- The contaminants have already been identified and are known to be persistent in the environment with the potential to pose a long term hazard if left on-site.

7.3.2 *Excavation of Impacted Soils with Treatment and/or Disposal*

Excavation and disposal of the areas of concern would involve removing the soil that has been deemed contaminated and either treating the material or disposing it at a licensed landfill. Both of these options are considered costly and time consuming given the quantity of contaminated material at the Site (estimated to be as mush as 260 000 cubic metres). This alternative only addresses soil that may require removal as part of the Stage 1 works.

Soil to be removed off-site would be classified, stabilised, transported and disposed at an appropriately licensed landfill in accordance with the NSW EPA (1999) *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes*. In addition, excavated soils may also be assessed with respect to the Environmentally Hazardous Chemicals Act (1985) Chemical Control Order in Relation to Scheduled Chemical Wastes and handled as appropriate.

This remedial methodology would increase confidence that the source is removed and removes the need for ongoing management or maintenance, but would prevent completion in a timely manner. As such, it has not been considered for this Stage 1 remediation.

7.3.3 *On-site Management*

On-site management of soil would involve leaving impacted soils in-situ and maintaining a hardstand cover over the affected surfaces. In the short term, managing the contaminated soils on-site is a viable and practical option to reduce the opportunity for exposure and minimise interim remediation costs. It is noted that the proposed Stage 1 demolition works indicates that all of the contaminated areas will continue to be covered with hardstand. Accordingly, it is considered appropriate to leave impacted soils at these locations in-situ, as a hardstanding capping layer will be maintained across the Site.

This remedial methodology would allow for remediation to be completed in a timely manner for a reduced cost than the options presented in *Section 7.3.2*; however, ongoing management or maintenance will be required.

7.4 *RATIONALE FOR SELECTION OF PROPOSED OPTION*

The preferred remedial option is *On-site Management*. Where practical, contractors will remove the concrete footings and regrade the pavements without excavating impacted soils. Should small volumes of soil need to be excavated for access, stockpiles will be managed, sampled and classified in accordance with all relevant guidelines.

This combination of remedial options satisfies the Stage 1 remediation goals and is cost effective. Any additional sources identified or changes to Stage 1 demolition plans may require a re-evaluation of these options.

7.5 *SCOPE OF REMEDIAL WORKS*

It is envisaged that the Remedial Works will comprise the following scope:

- Removal/demolition of all footings which protrude above slab level;
- Appropriate off site disposal/recycling of demolition materials in accordance with relevant legislative requirements;
- Reinstatement of concrete or asphaltic concrete surface in areas where footings or other structures have been removed and underlying soils exposed;
- Final preparation of the site such that the surface is covered with concrete/asphaltic concrete hard-standing and no significant trip hazards exist;
- Validation of the surface reinstatement works by a suitably qualified environmental consultant; and
- Sign off of the site works by a NSW DEC accredited Site Auditor.

All work shall be completed in accordance with the *ERM (2007) Draft Environment and Construction Management Plan*.

7.6 *PROPOSED VALIDATION METHODOLOGY*

The proposed validation methodology will involve three primary components:

- a detailed inspection of the site surface including photographing/mapping any areas of significant cracking or other areas where a potential for increased exposure may exist;
- flux chamber monitoring and/or ambient air monitoring for volatile organic compounds in areas where impacts exceeding the identified tier one screening criteria are identified. These sampling works will target areas of high risk such as drain pits and joints or cracks in hardstanding; and
- assessment of the potential risks posed by contamination via a quantitative health risk assessment conducted in accordance with NEPC (1999).

7.7 *CONTINGENCY PLANS*

The unexpected conditions that could feasibly occur at the Site include:

- Uncovering of presently unknown types of contamination;
- Difficulty in removing footings, which results in large volumes of excavated material;
- Generation of unacceptable levels of dust;
- Generation of unacceptable levels of odour;
- Spills and leaks of hazardous materials; and
- Excessive vapour emissions from certain areas.

Procedures that will be used to address these contingencies are provided in the following sections.

7.7.1 *Unknown Types Of Materials*

The presence of unknown materials would be highlighted during works by the observation of any unusual physical or sensory characteristics of the soils, results of vapour monitoring or validation sampling.

In the event that any significant unknown type of material is identified, work will be stopped, and an assessment of the influence of the material on Stage 1 Works would be undertaken. If necessary, a change or addendum would be added to the Stage 1 RAP, which would require approval from the Auditor prior to re-commencement of work. All additional work would be documented and detailed in the final validation report.

7.7.2 *Increased Volumes*

Throughout Stage 1, the quantity of materials encountered will be monitored. In the case of a significant increase in the estimated volume of waste soils, a review of the remediation strategy will be undertaken by a qualified environmental engineer or scientist.

7.7.3 *Dust Control*

Where unacceptable levels of dust are considered to have been generated, the Contractor shall initially suppress ambient dust by:

- Water sprays applied by spray nozzle or water misting hoses; or
- Secure sheeting over exposed areas.

In the event that additional measures are required, the Contractor shall be directed to modify the dust minimisation procedures to achieve acceptable air quality levels. Modifications may include:

- Reduction in area of exposed surfaces;
- Installation of perimeter sprays;
- Conducting work in more favourable weather conditions; and
- Use of chemical dust-suppressants, provided that the chemicals do not pose any risk from further contaminating the ground or surface waters and do not pose any unacceptable health and safety hazard.

Where unacceptable dust levels are considered to have been primarily generated from the equipment, the Contractor shall initially be instructed to:

- Modify the operation of the equipment;
- Modify the manner in which work is being conducted; or
- Install additional dust suppression features on the equipment.

In the event that additional measures are required, the Contractor shall be directed to modify operations to achieve acceptable air quality levels. Modifications may include:

- Using different equipment which generates less dust; or
- Using equipment in more favourable weather conditions.

7.7.4 *Odour Control*

Odour generation will be kept to a minimum through the use of water sprays and mists. Should excessive odour levels be generated, on-site monitoring using a photoionisation detector will be used. In extreme cases, odour suppressant may be sprayed.

7.7.5 *Spills and Leaks*

It is not anticipated that significant volumes of hazardous liquids will be stored at the Site during the Stage 1 works, although minor, incidental amounts of fuel and/or oils may be required by the Contractor. The Contractor should minimise the amount of these types of liquid stored at the Site; however, the following measures shall be implemented to protect the surrounding areas from hazards posed by chemical spills and leaks:

- Presence of emergency supply spill control equipment (e.g. oil absorbent materials); and
- Containment of any storage tanks or drums within bunded areas having a capacity of 110% of the largest tank contained or 25% of the total volume of all drums, whichever is greater.

7.7.6 *Excessive Vapours*

Should vapour monitoring indicate that excessive vapours are being emitted from the hardstanding areas, the following controls will be implemented:

- Cordon off or restrict access to areas, as appropriate;
- Install ambient air monitoring around perimeters of specified problems areas; and
- Place building restrictions on areas of concern to prevent capture of vapour in enclosed spaces.

7.8 ENVIRONMENTAL MANAGEMENT PLAN

A summary of major environmental issues associated with the Stage 1 RAP demolition and site clearance works is provided in *Table 7.1.* These issues along with appropriate mitigation measures are addressed in *ERM (2007) Draft Environmental and Construction Management Plan (Demolition).*

Table 7.1 Identified Environmental Issues - Demolition

Aspect	Potential Issue/ Impact
Air Quality	Generation of dust from demolition and footing removal activities;
	Mobilisation of asbestos or synthetic mineral fibres during removal of hazardous building materials
	Odours and vapours generated from contaminated materials exposed during removal of footings.
	Mobilisation of lead dust during removal of lead paints.
	Particulate generation from plant and vehicle emissions.
Surface Water Quality and Sedimentation	Sediment laden surface runoff entering Sydney Harbour or the stormwater system.
	Contaminated soil or sediment entering Sydney Harbour or the stormwater system.
	A spill or disposal of a hazardous substance causes pollution of the environment.
Waste	Inappropriate disposal of hazardous building materials, general demolition or other wastes generated by the works.
	Disposal of materials to landfill which could otherwise be reused or recycled.
	Cross contamination of clean materials or similar.
Heritage Issues	There are a number of heritage structures present on the site which could potentially be impacted by the works. A separate Heritage Impact Statement has been prepared by City Plan Heritage to address issues associated with these potential impacts.
Noise and Vibration	Generation of excessive noise or vibration may impact upon neighbouring residents/businesses. A separate plan entitled Acoustic Impacts Assessment and Mitigation Report has been prepared by Acoustic Logic to address issues associated with these potential impacts.
Traffic and Access	The demolition works will involve significant numbers of light and heavy vehicle movements. A separate plan entitled Construction Traffic Management Plan has been prepared by Jamieson Foley to address issues associated with these potential impacts.

7.9 *OCCUPATIONAL HEALTH AND SAFETY*

A detailed site Health & Safety Plan (HSP) shall be developed by the Contractor and submitted to the Foreshore Authority for approval prior to the commencement of remediation works. The HSP aims to protect the health and safety of all workers on the site, as well as the general safety of surrounding properties. The HSP shall be in accordance with the *NSW OH&S Act (2000)*, *NSW WorkCover* and any additional governing regulations. Prior to commencing work, all Contractor personnel will sign-off on the HSP to certify that they have read, understand and agree to abide by the contents of the HSP.

It is anticipated that all work will be performed using a minimum of Level D PPE, which includes but is not limited to steel-toed boots, protective eyewear with side shields, hearing protection and hardhat. All the safety equipment shall meet all applicable Australian Standards (AS).

The site has known contaminants that may require removal. The Contractor may come into contact with the contamination during the proposed scope of work. As such, all potential chemicals identified in *Table 6.1* will need to be considered when developing the HSP.

In addition, potentially asbestos containing material has been identified in the remediation areas, which will require appropriate abatement and control measures if removal is required. These mitigation measures will also need to be detailed in the HSP.

At a minimum the HSP shall include:

- The Contractor must provide details surrounding their health and safety programme including an induction process for all personnel working on the Site, as well as incident management and reporting plans;
- Where applicable, detailed safe work method statements shall be developed by appointed sub-contractors prior to the commencement of any work;
- Emergency phone numbers;
- A map showing the shortest route to nearby hospitals or health centres;
- Daily safety meeting content and procedures;
- Definition of roles and responsibilities of personnel, including staff and other contractors;
- Hazard identification procedures and control measures;
- Material safety data sheets;

- Soil, water and material handling procedures;
- Personal protective equipment;
- Work zones, traffic routes and stockpile areas;
- Decontamination procedures;
- Contingency plans; and
- Incident management and reporting plans.

Project team members shall be trained on contents of HSP prior to mobilisation to the field. All employees will sign-off on the HSP to certify that they have read, understand and agree to abide by the contents of the HSP. A copy of the sign-off sheet must be provided to the Foreshore Authority. Copies of the HSP, safe work method statements and the sign-off sheets must be available in the field.

7.10 REMEDIATION SCHEDULE

To be completed following receipt of requested information from SHFA.

7.11 STAKEHOLDER COMMUNICATION PLAN

As required by under NSW EPA Auditor Guidelines, a communication plan shall be required to notify all stakeholders and neighbouring properties of the activities on site. The Foreshore Authority shall maintain full responsibility for all stakeholder communication issues

8 *LIMITATIONS*

The findings of this report are based on the findings of ERM and previous site investigations and associated scope of works. ERM performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental consulting profession. No warranties, express or implied, are otherwise made.

Subject to the Scope of Work, ERM's assessment is strictly limited to remediating potentially adverse environmental conditions associated with the subject property and does not include evaluation of the structural conditions of any buildings on the subject property or any other issues.

The absence of any identified hazardous or toxic materials on the subject property should not be interpreted as a guarantee that such materials do not exist on the site.

The remediation and validation strategy presented herein is based upon site inspections and sampling conducted by ERM personnel and information from available reports outlining site conditions. All conclusions and recommendations regarding the property are the professional opinions of the ERM personnel involved with the project, subject to the qualifications made above.

While normal assessments of data reliability have been made, ERM assumes no responsibility or liability for errors in any data obtained from regulatory agencies, statements from sources outside of ERM, or developments resulting from situations outside the scope of this project.

ERM is not engaged in environmental consulting and reporting for the purpose of advertising sales promoting, or endorsement of any client interests, including raising investment capital, recommending investment decisions, or other publicity purposes.

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Annex A

Figures

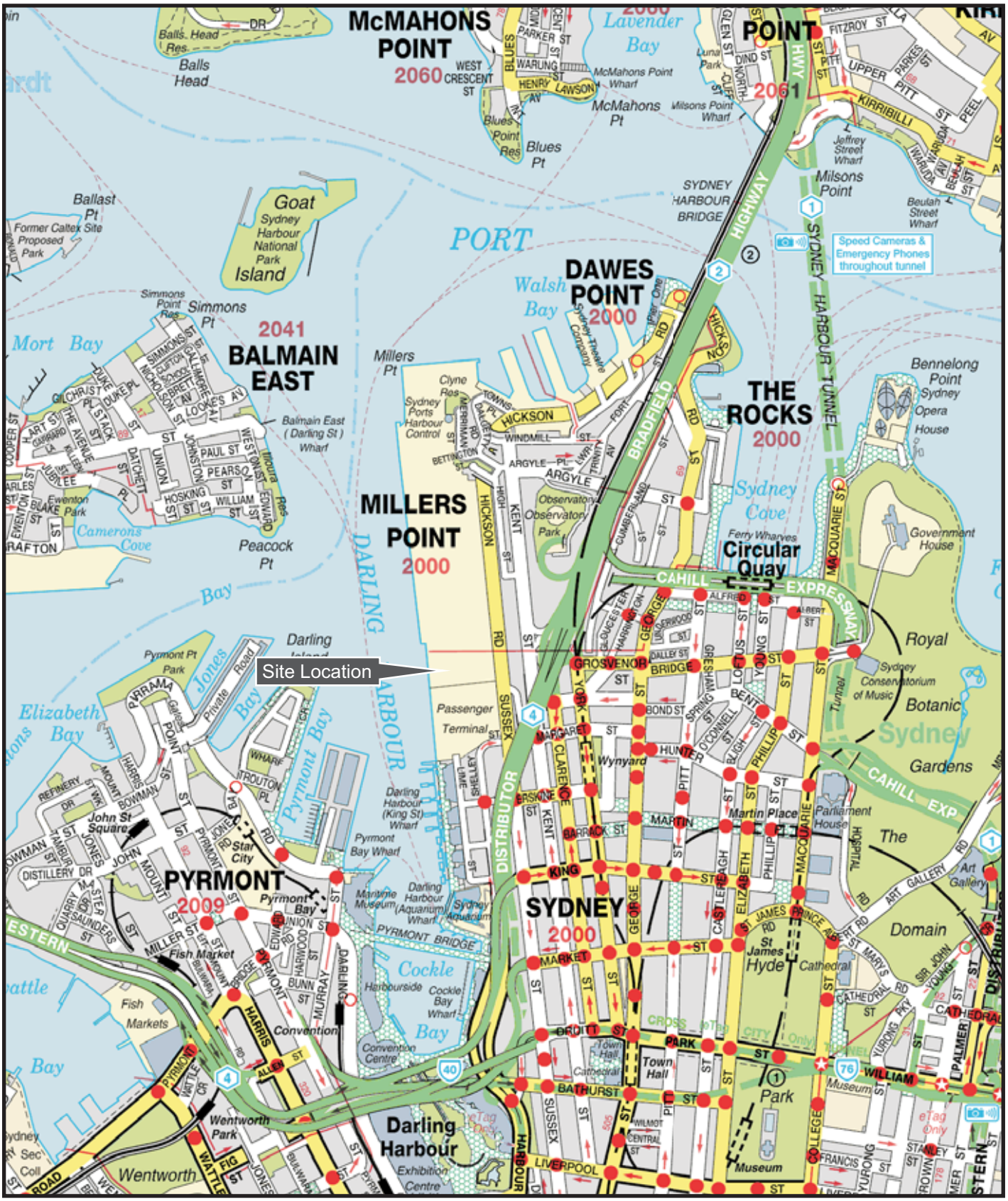

Figure 1

Site Location Plan

Client:	Sydney Harbour Foreshore Authority	
Project:	Barangaroo (Formerly East Darling Harbour) Stage 1 RAP	
Drawing No:	0065952s_T3_01	
Date:	18/06/2007	Drawing size: A4
Drawn by:	GC	Reviewed by: -
Source:	-	
Scale:	Refer to Scale Bar	

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0 100 200 300m

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ERM

Legend

- Monitoring Well
- Geo. / Env. Boreholes
- Environmental Boreholes
- Site / Lot Boundaries
- Buildings
- Potential Areas of Concern
- Indicative Location of Former Gasworks Structures

Figure 2

Client:	Sydney Harbour Foreshore Authority
Project:	Barangaroo
Drawing No:	0065952s_T3_SIR02
Date:	18/06/07 — Drawing size: A3
Drawn by:	MA — Reviewed by: PL
Source:	Rygate and Company Survey
Scale:	Refer Scale Bar

N

0 50 100 150m

Site Layout Plan
Barangaroo, NSW

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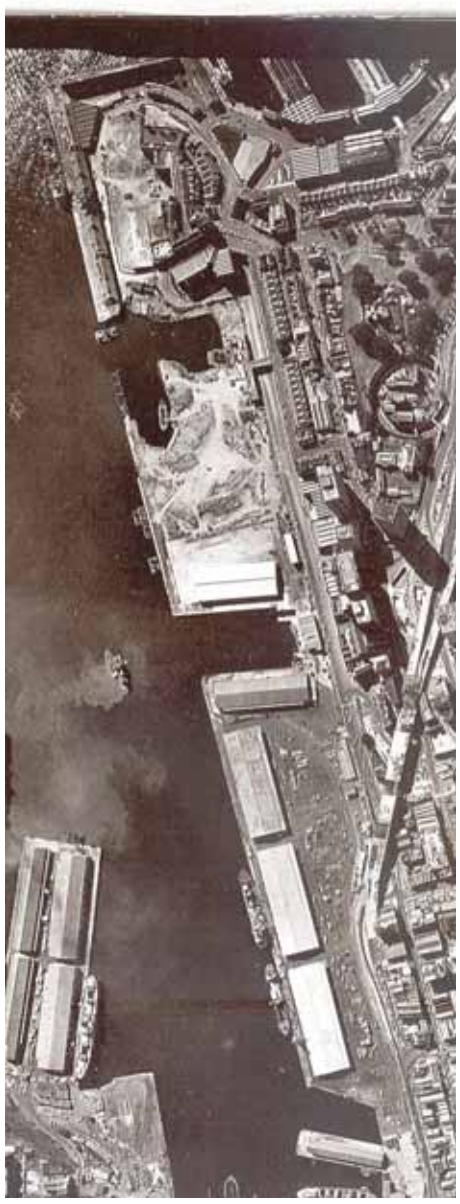
ERM

1951

1972



1983

2004

Figure 3

Aerial Photos 1951 - 2004

Client:	Sydney Harbour Foreshore Authority		
Project:	Barangaroo (Formerly East Darling Harbour) Stage 1 RAP		
Drawing No:	0065952s_T3_02		
Date:	18/06/2007	Drawing size:	A3
Drawn by:	GC	Reviewed by:	-
Source:	-		
Scale:	N/A		

N

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Legend

- Site Boundary
- Underground Water Lines
- Underground Sewer Lines
- Underground Power and Gas
- Drainage Lines

Figure 4

Client:	Sydney Harbour Foreshore Authority
Project:	Barangaroo
Drawing No:	0065952s_T3_SIR04
Date:	18/06/07 Drawing size: A3
Drawn by:	PL Reviewed by: LR
Source:	Rygate and Company Survey
Scale:	Refer Scale Bar

N

0 50 100 150m

Major Underground Services Layout
Barangaroo, NSW

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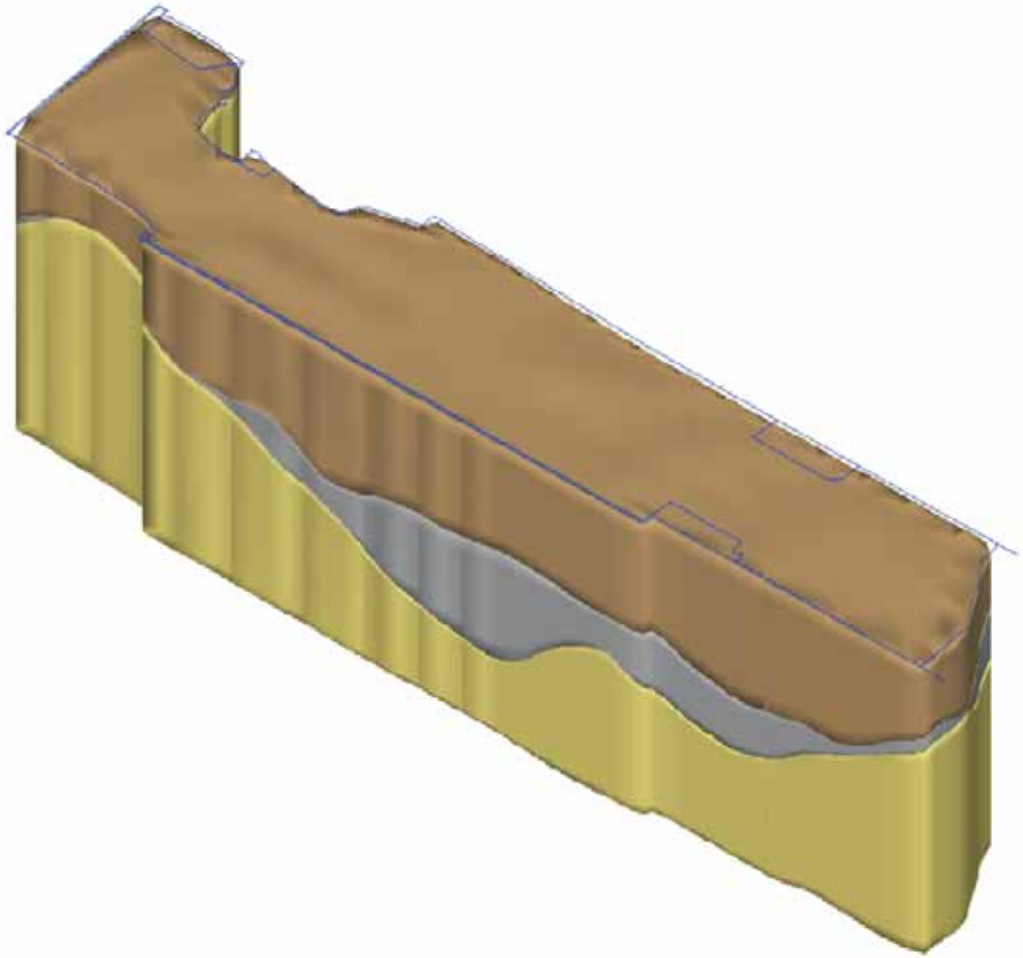

Unit

Fill

Sandy Clay

Sandstone

Figure 5

Geological Model

Client:	Sydney Harbour Foreshore Authority	
Project:	Barangaroo (Formerly East Darling Harbour) Stage 1 RAP	
Drawing No:	0065952s_T3_03	
Date:	18/06/2007	Drawing size: A4
Drawn by:	GC	Reviewed by: -
Source:	-	
Scale:	Not to Scale	

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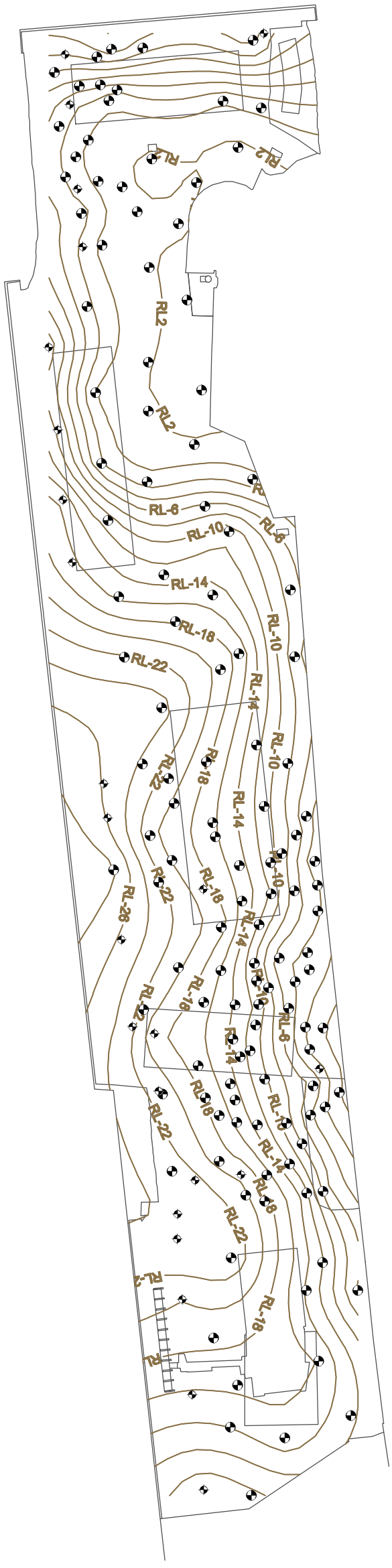

Legend

- Interpreted Bedrock Elevations (m)
- Site Features
- Boreholes
- Monitoring Wells

Figure 6

Interpreted Bedrock Elevations

Client:	Sydney Harbour Foreshore Authority		
Project:	Barangaroo		
Drawing No:	0065952s_T3_SIR06		
Date:	18/06/07	Drawing size:	A3
Drawn by:	MA	Reviewed by:	PL
Source:	Jeffrey and Katauskas Pty Ltd		
Scale:	Refer Scale Bar		

N

0 25 50 100 Metres

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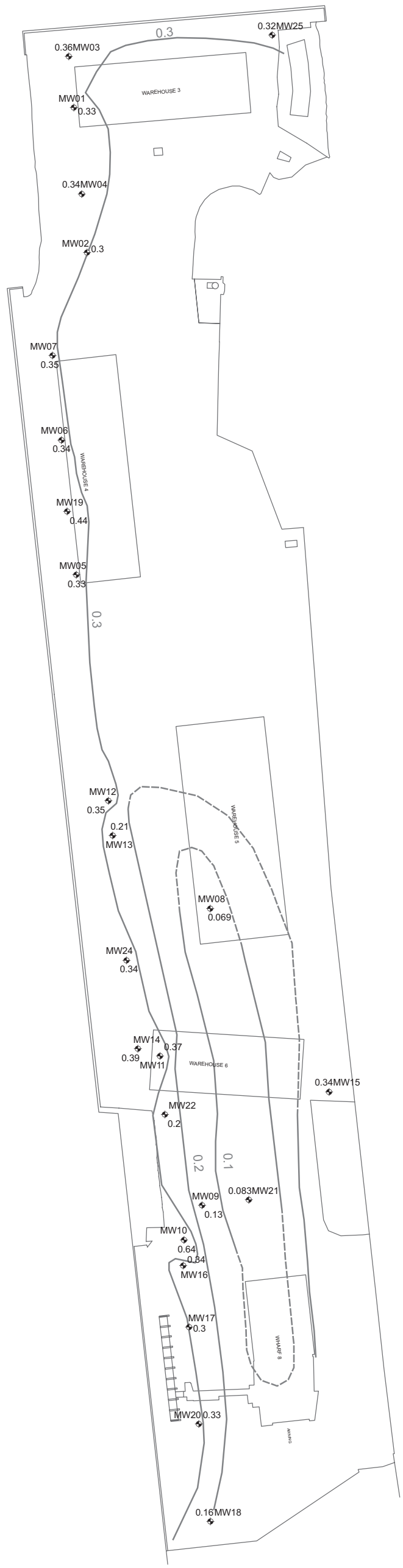

Legend

- Site features
- Interpreted Groundwater Contours
- Inferred Groundwater Contours
- Monitoring Wells & GW Elevations (mAHD)

Figure 7

Groundwater Contours

Client:	Sydney Harbour Foreshore Authority	
Project:	Barangaroo (Formerly East Darling Harbour) Stage 1 RAP	
Drawing No:	0065952s_T3_05	
Date:	18/06/2007	Drawing size: A3
Drawn by:	GC	Reviewed by: -
Source:	Survey Data Provided By Rygate & Company	
Scale:	Refer to Scale Bar	

N

0 50 100m

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